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Assessment of the Effect of Incisional Negative Pressure Wound Therapy for Prevention of Median Sternotomy Wound Infection

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ABSTRACT

Background: Sternal wound infection is a catastrophic complication after open heart surgery, so many studies have evaluated the effect of negative pressure wound therapy (NPWT) to prevent it. **Objective:** This study aimed to evaluate the impact of incisional negative pressure wound therapy on the wound healing process after midline sternotomy in open heart surgery. **Patients and methods:** 100 patients who underwent open heart surgery with midline sternotomy were included. They were divided equally into two groups: Group A included 50 patients who had negative pressure wound therapy and group B that contained 50 patients who had conventional wound dressing. **Results:** Patients who underwent negative pressure wound therapy had significantly lower incidences of TLC rising (P=0.043), and CRP rising (P=0.017), significantly lower incidences of overall post-operative wound infection (P=0.025), significantly lower post-operative progression to deep wound infection (P=0.024), significantly lower need for post-operative deep wound intervention (P=0.012), significantly shorter ICU stay (P=0.001), as well as shorter hospital stay (P=0.018) when compared to patients who had conventional wound dressing. Also, no mortality was detected among our studied patients. **Conclusion:** Negative pressure wound therapy was superior to conventional wound dressing as it was associated with significantly lower incidences of TLC and CRP rising, significantly lower incidences of overall post-operative wound infection and post-operative deep wound infection, significantly lower need for post-operative deep wound intervention, as well as significantly shorter ICU stay (due to readmission) and hospital stay, when compared to conventional wound dressing.

Keywords: Median sternotomy wound infection, Open heart surgery, Incisional negative pressure wound therapy.

INTRODUCTION

Being the standard incision for open heart surgery, median sternotomy is a very common surgical incision [(1)]. It may be associated with multiple complications. One of its common complications is the sternal wound infection, which is a huge burden increasing the morbidity and mortality after open heart surgery [(2-4)].

Lately the negative pressure wound therapy was the subject of multiple studies to determine its effectiveness in preventing sternal wound infections [(5-8)]. So, this study aimed to evaluate the impact of incisional negative pressure wound therapy on the wound healing process after midline sternotomy in open heart surgery.

PATIENTS AND METHODS

This research was conducted in Kasr Al-Ainy Hospitals after ethical committee approval as a prospective non-randomized study. 100 patients who underwent open heart surgery through median sternotomy in our institute from October 2023 to March 2024. They were equally divided into two groups according to surgeon preference:

- Group A: 50 patients who had negative pressure wound therapy.
- Group B: 50 patientswho had conventional wound dressing.

Exclusion criteria: We excluded emergency surgery, uncontrolled diabetic patients and minimally invasive surgery.

We recorded all preoperative, intraoperative and postoperative data.

Group A (NPWT):

1. The wound and the skin around the incision were cleaned, then sterilization of the wound was done.
2. A layer of sterile sponge was applied on the wound.
3. A catheter suction was applied followed by another layer of sterile sponge.
4. The wound was covered with air tight dressing.
5. A suction catheter was connected to intermittent low suction (can be disconnected to allow patient ambulation).
6. Dressing was changed daily.

Group B (Conventional dressing):

1. The wound and skin around incision were cleaned by betadine and then betadine was cleaned.
2. Squeezing the wound by gauze dressing.
3. Apply spray antibiotics.
4. Apply dressing along the wound then plaster.
5. Dressing was changed daily.

Ethical approval: The Medical Ethics Committee of Faculty of Medicine, Cairo University approved this study. After obtaining all of the information, all participants gave their signed consents. The Helsinki Declaration was observed throughout the study's conduction.

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Statistical analysis

Data were coded and entered using the statistical package for social science (SPSS) version 26. Data were checked for normality using Shapiro-Wilk test. Data were summarized using number and percent for qualitative variables, mean and standard deviation for quantitative normally distributed variables. Comparison between groups was done using Chi-square test or fisher's exact test appropriate for qualitative variables, and independent samples T-test for independent comparisons of quantitative normally distributed variables. P value less than or equal to 0.05 was considered as statistically significant

RESULTS

In our preoperative data there were no statistically significant differences regarding demographic data, comorbidities and preoperative ejection fraction to avoid selection bias (where both groups didn't show significant difference regarding neither their age, gender, BMI, nor chronic disease status) (Table 1).

Table (1): Preoperative data

	Group A VAC (n=50)	Group B (n=50)	P value
Gender Male Female	 31 (62) 19 (38)	 33 (66) 17 (34)	0.677
Age (Mean ± SD) in years	54.36 ± 14.7	53.46 ± 12.5	0.743
BMI (Mean ± SD) kg/m^2	23.6 ± 2.9	24.2 ± 2.6	0.282
Smoking Yes No	 24 (48) 26 (52)	 28 (56) 22 (44)	0.423
Comorbidities* Yes No	 31 (62) 19 (38)	 33 (66) 17 (34)	0.677
DM Yes No	 21 (42) 29 (58)	 20 (40) 30 (60)	0.839
HTN Yes No	 19 (38) 31 (62)	 21 (42) 29 (58)	0.683
CKD Yes No	 1 (2) 49 (98)	 4 (8) 46 (92)	0.362
COPD Yes No	 4 (8) 46 (92)	 2 (4) 48 (96)	0.678
Echo EF (Mean ± SD)	56.46 ± 8.7	55.08 ± 8.7	0.430

Also, our results didn't show statistically significant differences regarding the intraoperative data (Table 2).

Table (2): Intraoperative data

	Group A VAC (n=50)	Group B (n=50)	P value
Procedure type CABG Valve surgery Adult congenital surgery Aortic surgery	 29 (58) 18 (36) 3 (6) 0 (0)	 32 (64) 12 (24) 4 (8) 2 (4)	0.322
CPB On pump Off pump	 44 (88) 6 (12)	 45 (95) 5 (5)	0.749
CPB time (Mean ± SD) in minutes	157.16 ± 49.5	142.4 ± 41.9	0.134
Cross clamp time (Mean ± SD) in minutes	96.8 ± 34.05	89.9 ± 20.01	0.247
Operative time (Mean ± SD) in minutes	290.6 ± 55.6	313.2 ± 65.25	0.066

Postoperatively, TLC and CRP showed a significant difference between groups; where rising of TLC and CRP were greater among group B patients (36% and 42% respectively) than among group A patients (18% and 20% respectively). (P value for rising TLC = 0.043 & P value for rising CRP = 0.017) (Figure 1 & table 3).

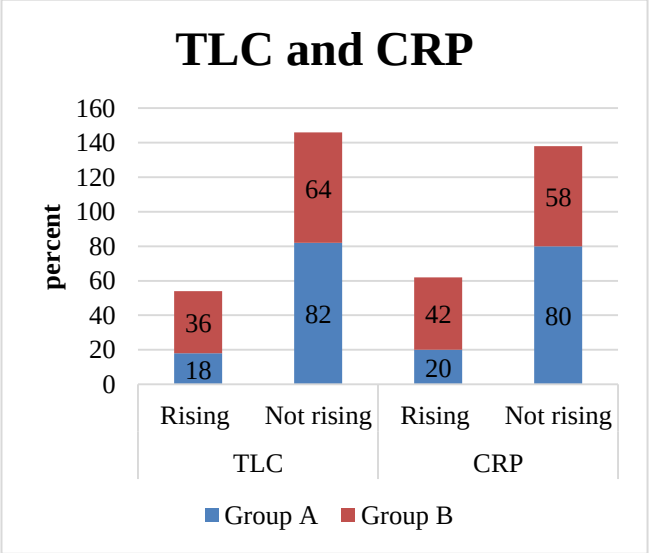

Figure (1): TLC and CRP among patients.

Moreover, wound infection was more prevalent among group B patients (9, 18%) than group A patients (4, 8%) (P Value =0.025) (Figure 2 & table 3).

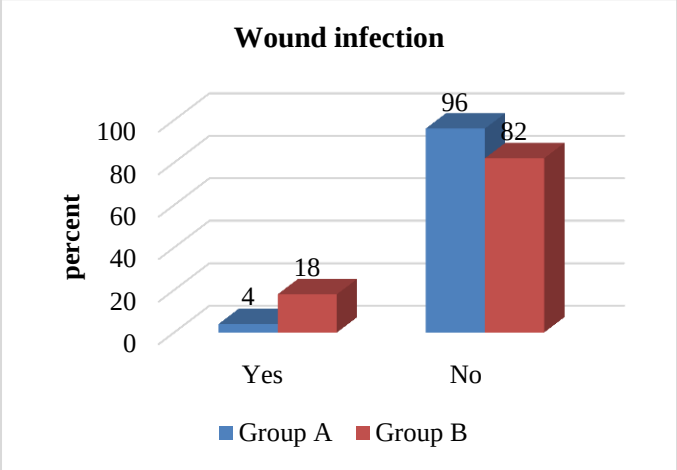

Figure (2): Wound infection among patients.

Also, infected wounds among group A patients were all superficial skin infection, while group B wounds showed 5 (55.6%) superficial skin infection and 4 (44.4%) deep sternal wound infection (DSWI) (P Value=0.024) (Figure 3 & table 3).

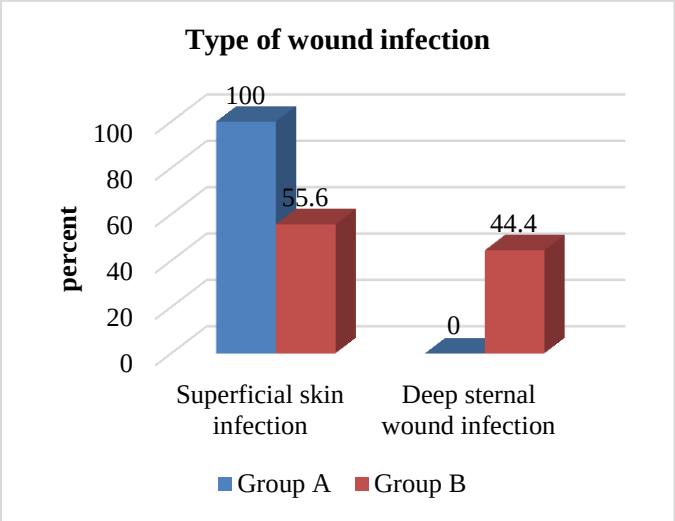

Figure (3): Type of wound infection among patients.

Moreover, wound intervention was performed for group B patients only in the form of one omental flap, two pectoral flaps, two vacuum, and two wound debridement and pectoral flaps. Also, no mortality was detected among patients (Figure 4 & table 3).

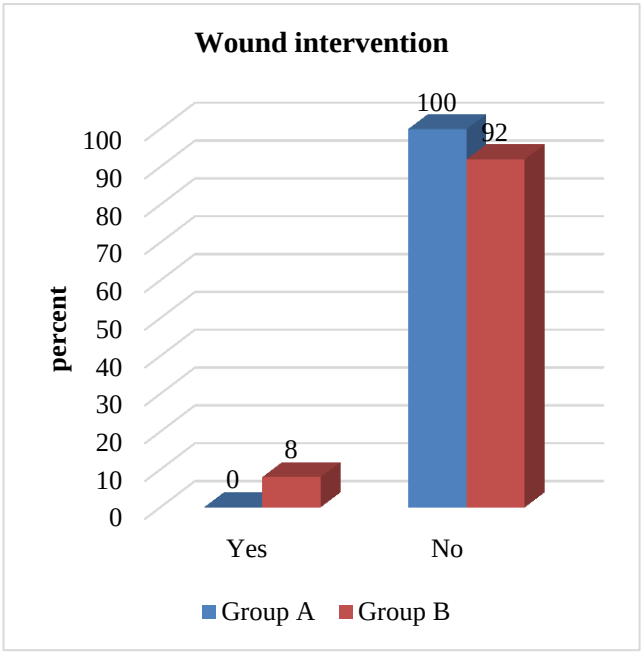

Figure (4): Wound intervention among patients.

Regarding post-operative events, the mean length of hospital stay and ICU stay was much prolonged among group B patients (9.26 ± 3.6 and 4.4 ± 1.01 days respectively) than among group A patients (7.72 ± 2.7 and 3.6 ± 1.4 days respectively), with a statistically significant difference between them (P value for ICU stay = 0.001 & P value for hospital stay = 0.018) (Figure 5 & table 3).

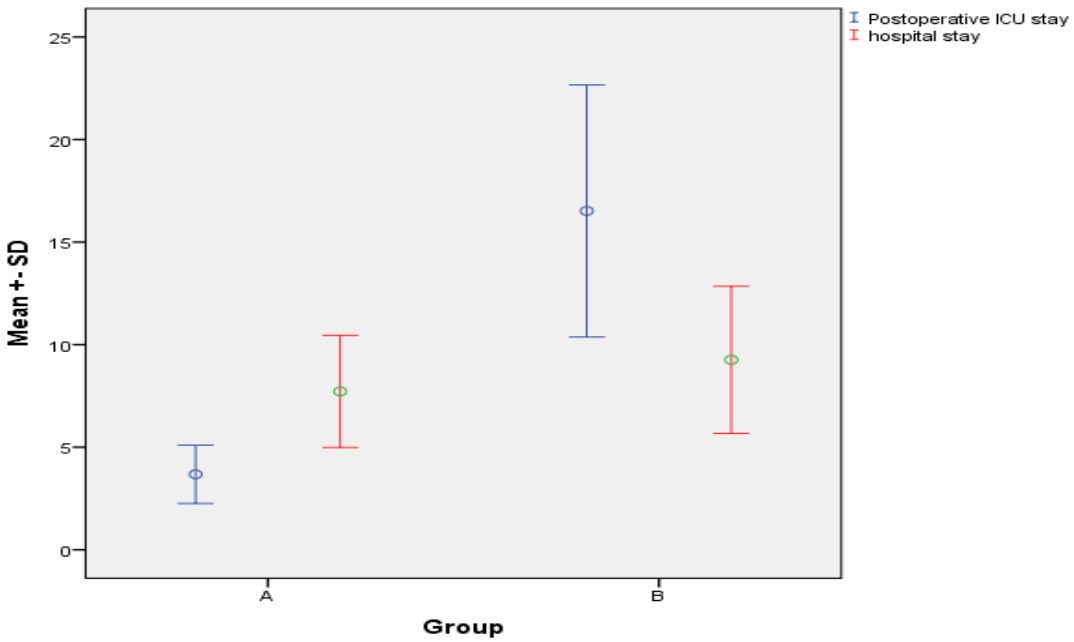

Fig. (5): Error bar showing postoperative ICU stay and hospital stay among patients.

Table (3): Postoperative data.

		Group A VAC (n=50)	Group B (n=50)	P value
Supports	Yes	38 (76)	43 (86)	
	No	12 (24)	7 (14)	0.202
Supports dose	High dose	10 (26.3)	9 (20.9)	
	Low dose	28 (73.7)	34 (79.1)	0.377
Postoperative ICU stay (Mean± SD) in days		3.6 ± 1.4	4.4 ± 1.01	**0.001**
Hospital stay (Mean ± SD) in days		7.72 ± 2.7	9.26 ± 3.6	**0.018**
Total leukocytic count	Rising	9 (18)	18 (36)	
	Not rising	41 (82)	32 (64)	**0.043**
C-reactive protein	Rising	10 (20)	21 (42)	
	Not rising	40 (80)	29 (58)	**0.017**
Wound infection	Yes	2 (4)	9 (18)	
	No	48 (96)	41 (82)	**0.025**
Type of wound infection	Superficial skin infection	2 (100)	5 (55.6)	
	Deep sternal wound infection	0 (0)	4 (44.4)	**0.024**
Fever	Yes	7 (14)	13 (26)	
	No	43 (86)	37 (74)	0.134
Wound intervention	Yes	0 (0)	4 (8)	
	No	50 (100)	46 (92)	**0.012**
Wound intervention; yes	Omental flap	0 (0)	1 (25)	
	Pectoral flap	0 (0)	1 (25)	
	Vacuum	0 (0)	1 (25)	-
	Wound debridement and pectoral flap	0 (0)	1 (25)	
Mortality	Yes	0 (0)	0 (0)	
	No	50 (100)	50 (100)	-

DISCUSSION

Our study compared NPWT to conventional wound therapy to determine the efficacy of NPWT in preventing sternal wound infections following open heart surgery hoping to decrease the morbidity and mortality following these major surgeries.

Our study showed that patients who underwent negative pressure wound therapy had significantly lower incidence of overall post-operative wound infection (4% vs 18%; P=0.025), when compared to patients who had conventional wound dressing. Also, the incidence of deep wound infection was 0% in NPWT group vs 8% in conventional group showing that NPWT group infections tends to be more superficial protecting from the catastrophic deep sternal infections. These results go with **Rashed *et al.*[8]** results, which also showed that NPWT decreased the incidence of deep sternal infection (P = 0.026) and

also showed 0% deep sternal infections in the NPWT group. Also, **Traylor *et al.*** [5] showed the NPWT is effective in preventing sternal infections ($p < 0.001$). **Witt-Majchrzak *et al.*** [9] agrees with our study that NPWT has a protective effect against DSWI (2.5% vs 17.5%; P=0.0254).

In contrast to our study, **Ruggieri *et al.*** [10] reported that patients who underwent isolated CABG with BIMA grafting showed similar surgical wound infections distribution between the conventional sterile wound dressing (10.9%) and the INPWT cohorts (10.2%). Superficial wound infection was more in the NPWT group and deep wound infection was more in the conventional group however both were statistically insignificant. Lack of p-value significance in Ruggieri' study can be attributed to including only patients with BIMA grafts and the allocation of more diabetics and obese patients in the NPWT group.

Deep surgical wound infection (DSWI) may be catastrophic causing ICU readmission, prolonged hospital stay, long-term expensive antibiotics, surgical intervention, higher mortality, and increased patient suffering and health care costs [1-3].

Our study showed that patients who underwent negative pressure wound therapy had significantly lower need for post-operative deep wound intervention (0% vs 8%; P=0.012) when compared to patients who had conventional wound dressing. Supporting our findings, **Grauhan *et al.*** [11] showed statistically significant (p-value < 0.05) incidence of sternal wound infection requiring surgical revision between both groups.

Our study concluded that NPWT had a beneficial effect on the inflammatory markers as the use of negative pressure wound therapy was associated with significantly lower incidences of TLC rising (P=0.043), and CRP rising (P=0.017) when compared to conventional wound dressing, which is different from **Rashed *et al.*** [8] results, which showed no difference between both groups.

Post-operatively, patients who underwent negative pressure wound therapy had significantly shorter ICU stay due to ICU readmission in conventional group (P=0.001), as well as shorter hospital stay (P=0.018) when compared to patients who had conventional wound dressing. **Tabley *et al.*** [6] showed that there was increased hospital stay in both groups in the complicated cases.

Finally, no mortality was detected among our studied patients. Meanwhile, **Ruggieri *et al.*** [10] reported mortality in 2.34% of patients with no significant difference between INPWT and conventional sterile dressing groups.

CONCLUSION

Based on the present study, negative pressure wound therapy after midline sternotomy in open heart surgery was associated with significantly lower incidences of TLC and CRP rising, significantly lower incidences of overall post-operative wound infection and post-operative deep wound infection, significantly lower need for post-operative deep wound intervention, as well as significantly shorter ICU stay and hospital stay when compared to conventional wound dressing, which led to decreased health care costs.

Conflict of interest: none declared.
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